PATENT SPECIFICATION (11) 1258061

1258061

DRAWINGS ATTACHED

(21) Application No. 8968/68 (22) Filed 23 Feb. 1968

(23) Complete Specification filed 21 Feb. 1969

(45) Complete Specification published 22 Dec. 1971

(51) International Classification B 23 k 1/08, 1/20; C 23 c 3/00

(52) Index at acceptance

B3R 24

C7F 1A 1B1A 1B1B 2U 2Z3 3E 4A 4C

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(54) IMPROVEMENTS IN AND RELATING TO SOLDERED HEAT EXCHANGERS

(71) We, THE ENGLISH ELECTRIC COMPANY LIMITED, of 1 Stanhope Gate, London, W1A 1EH (formerly of English Electric House, Strand, London, W.C.2), a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

This invention relates to heat exchangers, and more particularly relates to a method of soldering a component(s) along a bore in an aluminium or light alloy body to produce a heat exchanger which serves for example, as a heat sink for diodes, thyristors or the like, a coolant fluid being passed through the bore. Such bodies may also perform the dual function of both heat sink and busbar.

The present invention provides a method of making a heat exchanger assembly by soldering a component along a bore in an aluminium or light alloy body, comprising the steps of passing through the bore a fluid containing a metallic compound which produces an immersion deposit of metal on the surface of the bore by displacement, followed by a mixture of a chemically reducible metallic salt and a reducing agent, thereby chemically to deposit a layer of solderable metal over the immersion deposit of metal on the surface of the bore, inserting the component into the bore in contact with the layer of solderable metal, flushing the bore with molten solder sufficiently to wet the mating surfaces of the component and bore, and subsequently cooling the assembly.

The deposited layer of solderable metal may be a nickel-phosphorous alloy which, together with the said component, is treated with a flux before soldering, and this soldering step may conveniently be effected by immersing and agitating the assembly in a solder bath. The component itself may be a wire coil wound about a central support and arranged to impart a turbulent flow to the coolant fluid, e.g. water or oil, passed through the bore.

By use of the plating/soldering technique, good heat-conductive contact is made between the "turbulator" and the aluminium body so as to give a high heat transfer rate between this assembly and the coolant fluid, and thereby readily dissipate heat from the electrical components secured to the assembly.

In order that the invention may be fully understood, one embodiment thereof will now be described, by way of example, with reference to the accompanying drawing the single figure of which illustrates a part-sectional side elevation through a heat exchanger assembly made by a method according to this invention.

Referring now to the drawing, the soldered assembly comprises a tubular body 1 of aluminium into which a turbulator has been inserted and soldered, this turbulator comprising a supporting spindle 2 around which is wound a coil 3 held in place by a wire thread 4; all these component parts may conveniently be made from copper.

In performing the method according to this invention, the tubular aluminium body is initially cleaned and is then connected in circuit with a fluid pump by means of hose connectors so that the bore lies vertically, or at least significantly upwardly inclined, in the fluid flow path. Following this, the surface of the bore is etched by pumping through aqueous solutions of 10% weight/vol. sodium hydroxide at say 50°C, 15% vol/vol sulphuric acid at say 90°C and 50% vol/vol nitric acid, at room temperature, in succession, with washes in demineralised water in between.

Subsequently, the surface is coated with an immersion deposit of zinc by displacement of aluminium by pumping through an aqueous solution of sodium hydroxide and zinc oxide e.g. 400 gms./litre and 80 gms./litre, respectively, at room temperature after which the bore is washed with de-mineralised water at say 90°C preparatory to an electroless nickel plating step. In this instance a solution comprising nickel chloride (30 gms/litre), tri-sodium citrate (100 gms/litre), sodium chloride (5 gms/litre), ammonium chloride (50 gms/litre) and a reducing agent sodium hypophosphite (10 gms/litre) is pumped

[Price 25p]

through the bore for, say 5 minutes at between 88°C and 90°C with pH between 8—10, depending on the plating thickness required of the nickel-phosphorous alloy which, in turn, is dependent on the time for which the subsequent soldering step is performed since the nickel tends to migrate into the solder, the soldering time increasing with the length of the bore required to be treated.

Finally, the bore is again washed through with de-mineralised water, dried, and then coated with a flux.

The turbulator in which, as mentioned above, the coil 3 is held by a wire thread 4 around a supporting spindle, is then fluxed and inserted into the bore, the outer surface of the coil 3 bearing against the surface of the bore.

The whole assembly is then completely immersed in a bath of molten 60/40—tin/lead solder and agitated by raising and lowering in a see-saw fashion so as to flush the bore with the solder and wet the mating surfaces of the turbulator and the bore. All the exposed surfaces are tinned during this process and care must be taken to ensure that the agitation is neither too violent, which could result in removal of the plating, nor too gentle, in which case the solder deposited may tend to bridge adjacent turns in the coil and restrict the coolant flow path through the assembly.

The assembly is then removed from the bath and cooled, a full-bodied soldered joint being formed between the turbulator and the aluminium body over the whole length of the bore.

Although the invention has been described with reference to a specific example it is to be understood that many modifications can be made to the steps described without departing from the scope of the invention. In addition, components other than the turbulator described for assisting the dissipation of heat by the coolant fluid may be inserted into the bore and affixed by the soldering method described.

WHAT WE CLAIM IS:—

1. A method of making a heat exchanger assembly by soldering a component along a bore in an aluminium or light alloy body, comprising the steps of passing through the bore a fluid containing a metallic compound which produces an immersion deposit of metal on the surface of the bore by displacement, followed by a mixture of a chemically reducible metallic salt and a reducing agent, thereby chemically to deposit a layer of solderable metal over the immersion deposit of metal on the surface of the bore, inserting the component into the bore in contact with the layer of solderable metal, flushing the bore with molten solder sufficiently to wet the mating surfaces of the components and bore and subsequently cooling the assembly.

2. A method according to Claim 1, comprising the step of etching the bore before the immersion deposition of said metal.

3. A method according to Claim 1 or Claim 2, wherein the immersion-deposited metal is zinc.

4. A method according to any one of Claims 1 to 3, wherein the chemically-deposited solderable metal is a nickel-phosphorous alloy.

5. A method according to Claim 4, wherein the said mixture from which the nickel-phosphorous alloy is deposited comprises nickel chloride, tri-sodium citrate, sodium chloride, ammonium chloride and sodium hypophosphite.

6. A method according to any one of Claims 1 to 5, wherein the bore is so disposed that the bore is vertical, or significantly upwardly inclined, whilst the fluids are pumped therethrough during the deposition steps.

7. A method according to any one of Claims 1 to 6, wherein the bore is flushed with molten solder by immersing and agitating the whole assembly in a bath of the solder.

8. A method of making a heat exchanger assembly, substantially as herein described.

9. A heat exchanger assembly made by a method according to any one of Claims 1 to 8.

10. A soldered heat exchanger assembly substantially as herein described with reference to the accompanying drawing.

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Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1971.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

1258061 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*